Softwaretechnik / Software-Engineering

Lecture 4: Software Project Management

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**Topic Area Project Management: Content**

- **VL 2**
  - Software Metrics
    - Properties of Metrics
    - Scales
    - Examples

- **VL 3**
  - Cost Estimation
    - "(Software) Economics in a Nutshell"
    - Expert's Estimation
    - Algorithmic Estimation

- **VL 4**
  - Project Management
    - Project
    - Process and Process Modelling

- **VL 5**
  - Process Metrics
    - CMMI, Spice
Content

- (Software) Project
- Project Management
  - Goals
  - Common Activities
  - Excursion: Risk
- Software Development Processes
  - Roles, Artefacts, Activities
  - Costs and Deadlines
    - phase, milestone, deadline
    - cycle, life cycle, software life cycle
- Development Process Modelling
  - process vs. process model
- Procedure and Process Models
  - "Code and Fix"
  - The (infamous) Waterfall Model

Project
**Vocabulary: Project**

*project* – A temporary activity that is characterized by having
- a **start date**,
- specific **objectives and constraints**,
- established **responsibilities**,
- a **budget and schedule**, and
- a **completion date**.

If the objective of the project is to develop a software system, then it is sometimes called a **software development project** or **software engineering project**.  

R. H. Thayer (1997)

We could refine our earlier definition as follows: a project is **successful** if and only if
- **started** at start date,
- **achieved** objectives,
- **respected** constraints,
- **adheres** to budget and schedule,
- **stops** at completion date.

Whether, e.g., objectives have been achieved can still be **subjective** (→ customer/user happy).

**Vocabulary: Software Project**

**(Software) Project** – Characteristics:
- **Duration** is limited.
- Has an **originator** (person or institution which initiated the project).
  - The **project owner** is the originator or its representative.
  - The **project leader** reports to the project owner.
- Has a **purpose**, i.e. pursues a bunch of goals.
  - The most important goal is usually to create or modify software; this software is thus the result of the project, the **product**.
  - Other important goals are extension of know-how, preparation of building blocks for later projects, or utilisation of employees.

The project is called **successful** if the goals are reached to a high degree.
- Has a **recipient** (or will have one).
  - This recipient is the **customer**.
  - Later users (conceptionally) belong to the customer.
- **Links** **people**, **results** (intermediate/final products), and **resources**.

The **organisation** determines roles of and relations between peoples/results/resources, and the **external interfaces** of the project.

Ludewig & Lichter (2013)
Goals and Activities of Project Management

- **Main and general goal:**
  - Have a **successful** project, i.e. the project **delivers**
    - defined **results**
    - in demanded **quality**
    - within scheduled **time**
    - using the assigned **resources**.
  
  There may be **secondary goals**, e.g.,
  - build or strengthen good **reputation** on market,
  - acquire **knowledge** which is useful for later projects,
  - develop **re-usable components** (to save resources later),
  - be attractive to **employees**.
  - ...

- **Main project management activities** (and **responsibilities** of project manager):
  - **Planning**
  - **Assessment and Control**
  - **Recognising and Fighting Difficulties as Early as Possible**
  - **Communication**
  - **Leading and Motivation of Employees**
  - **Creation and Preservation of Beneficial Conditions**
Common Activities of Project Management

- Planning
- Assessment and Control
- Recognising and Fighting Difficulties as Early as Possible
- Communication
- Leading and Motivation of Employees
- Creation and Preservation of Beneficial Conditions

Without plans, a project cannot be managed. Note: mistakes in planning can be hard to resolve.

Work results and project progress have to be assessed and compared to the plans; it has to be observed whether participants stick to agreements.

Unforeseen difficulties and problems in projects are not exceptional but usual. Therefore, project management needs to constantly “screen the horizon for icebergs”, and, when spotting one, react timely and effectively.

In other words: systematic risk management.

Distribute information between project participants (project owner, customer, developers, administration).

Leading means: going ahead, showing the way, “pulling” the group.

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Quick Excursion: Risk and Riskvalue

Risk — a problem, which did not occur yet, but on occurrence threatens important project goals or results. Whether it will occur, cannot be surely predicted.

Ludewig & Lichter (2013)

\[
\text{riskvalue} = p \cdot K
\]

- \( p \): probability of problem occurrence.
- \( K \): cost in case of problem occurrence.

Avionics requires: “Average Probability per Flight Hour for Catastrophic Failure Conditions of \( 10^{-11} \) or ‘Extremely Improbable’” (AC 25.1309-1).

“Problems with \( p = 0.5 \) are not risks, but environment conditions to be dealt with”
Common Activities of Project Management

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Distribute information between project participants (project owner, customer, developers, administration).

Communication

Leading and Motivation of Employees

Creation and Preservation of Beneficial Conditions

Leading means: going ahead, showing the way, "pulling" the group.

Most developers want to achieve good results, yet need orientation and feedback (negative and positive).

In other words:

Systematic risk management.

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Process

Process –

1. A sequence of steps performed for a given purpose; for example, the software development process.
2. See also: task; job.
3. To perform operations on data.

IEEE 610.12 (1990)

Software Development Process –

The process by which user needs are translated into a software product. The process involves translating user needs into software requirements, transforming the software requirements into design, implementing the design in code, testing the code, and sometimes, installing and checking out the software for operational use.

IEEE 610.12 (1990)

- The process of a software development project may be
  - implicit,
  - informally agreed on, or
  - explicitly prescribed (by a procedure or process model).

- Note: each software development project has a process!
Describing Software Development Processes

Over time, the following notions proved useful to describe and model (in a minute) software development processes:

- **role** – has responsibilities and rights, needs skills and capabilities.  
  In particular, has responsibility for artefacts, participates in activities.

- **artefact** – all documents, evaluation protocols, software modules, etc., all products emerging during a development process.  
  Is processed by activities, may have state.

- **activity** – any processing of artefacts, manually or automatic, solves tasks.  
  Depends on artefacts, creates/modifies artefacts.

The Concept of Roles

In a software project, at each point in time, there is a set $R$ of (active) roles, e.g. $R = \{ \text{mgr}, \text{prg}, \text{tst}, \text{ana} \}$.

A role has responsibilities and rights, and necessary skills and capabilities.

For example,

- **mgr** project manager
  - has the right to raise issue reports
  - is responsible for closing issue reports

- **prg** programmer
  - has the right to change the code
  - is responsible for reporting unforeseen problems to the project manager
  - is responsible for respecting coding conventions
  - is responsible for addressing issue reports

- **tst** test engineer
  - has the right to raise issue reports
  - is responsible for quality control
The Concept of Roles Cont’d

Given a set \( R \) of roles, e.g. \( R = \{ \text{mgr, prg, tst, ana} \} \), and a set \( P \) of people, e.g. \( P = \{ \text{a, b, c, d} \} \), each with skills or capabilities.

An aspect of project management is to assign (a set of) people to each role:

\[
\text{assign} : R \rightarrow 2^P
\]

such that each person \( p \in \text{assign}(r) \) assigned to role \( r \) has (at least) the skills and capabilities required by role \( r \).

Note: \( \text{assign} \) may change over time, there may be different assignments for different phases.

Sanity check: ensure that \( \text{assign}(r) \neq \emptyset \) for each role \( r \).

• Example:

\[
\text{assign} = \{ \text{mgr} \rightarrow \{ \text{a} \}, \text{prg} \rightarrow \{ \text{b, c, d} \}, \text{tst} \rightarrow \{ \text{a} \}, \text{ana} \rightarrow \{ \text{b} \} \}
\]

Useful and Common Roles

Recall: roles “Customer” and “Developer” are assumed by legal persons, which often represent many people.

The same legal person may act as “Customer” and “Developer” in the same project.

Useful and common roles in software projects:

• customer, user
• project manager
• (system) analyst
• software architect, designer
• (lead) developer
  programmer, tester, ...
• maintenance engineer
• systems administrator
• invisible clients: legislator, norm/standard supervisory committee
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**Common Activities in Order to Develop or Adapt Software**

- **Analysis**
  - Requirements Specification
  - Design, Specification of Modules
  - Coding and Module Test

  Software is developed to solve a problem or satisfy a need. **Goal** of analysis: understand the problem, assess whether/in how far software can be used to solve it. Resulting documents are basis of most other activities! **Formal methods**: check consistency, realisability.

- **Integration, Test, Approval**
  - Deployment, Operation, and Maintenance
  - Dismissing and Replacement

  Done if system is constructed from completed components, interplay is tested. Customer checks system and declares approval (or not). Done if system is installed up to customer needs and becomes operational. Occurring errors are fixed. New requirements (changes, extensions): new project (so-called maintenance project).

- **Deployment, Operation, and Maintenance**

  Implement the needed modules using the chosen programming language(s). Done if tested as needed, and ready for integration. **Formal methods**: verify code implements design.

- **Dismissing and Replacement**

  Most software systems (sooner or later) become obsolete, and are often replaced by a successor system. Common reasons: existing system no longer maintainable, not adaptable to new or changed requirements.
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**Phases, Milestones**

A **phase** is a continuous, i.e. not interrupted range of time in which certain works are carried out and completed. At the end of each phase, there is a **milestone**. A phase is **successfully completed** if the criteria defined by the milestone are satisfied. Ludewig & Lichter (2013)

- Phases (in this sense) do not overlap! Yet there may be different “threads of development” running in parallel, structured by different milestones.

- Splitting a project into phases makes controlling easier; milestones may involve the customer (accept intermediate results) and trigger payments.

- The **granularity** of the phase structuring is critical:
  - very short phases may not be tolerated by a customer.
  - very long phases may mask significant delays longer than necessary.

  **If necessary:**
  - define internal (customer not involved) and external (customer involved) milestones.
Milestones, Deadlines

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- Whether a milestone is reached (or successfully completed) must be assessable by:
  - clear,
  - objective, and
  - unambiguous criteria.
- The definition of a milestone often comprises:
  - a definition of the results which need to be achieved,
  - the required quality properties of these results,
  - the desired time for reaching the milestone (the deadline), and
  - the instance (person or committee) which decides whether the milestone is reached.
- Milestones can be part of the development contract; not reaching a defined milestone as planned can lead to legal claims.

Cycle and Life Cycle

cycle — (l) A period of time during which a set of events is completed. [...] IEEE 610.12 (1990)

software development cycle — The period of time that begins with the decision to develop a software product and ends when the software is delivered. [...] IEEE 610.12 (1990)

software life cycle — The period of time that begins when a software product is conceived and ends when the software is no longer available for use. [...] IEEE 610.12 (1990)

system life cycle — The period of time that begins when a system is conceived and ends when it is no longer available for use. IEEE 610.12 (1990)
software development cycle – The period of time that begins with the decision to develop a software product and ends when the software is delivered.

This cycle typically includes
- a requirements phase,
- a design phase,
- an implementation phase,
- a test phase, and
- sometimes an installation and checkout phase.

Notes:
1. The phases listed above may overlap or be performed iteratively, depending upon the software development approach used.
2. This term is sometimes used to mean a longer period of time, either the period that ends when the software is no longer being enhanced by the developer, or the entire software life cycle.

IEEE 610.12 (1990)

software life cycle – The period of time that begins when a software product is conceived and ends when the software is no longer available for use.

The software life cycle typically includes
- a concept phase,
- a requirements phase,
- a design phase,
- an implementation phase,
- a test phase,
- an installation and checkout phase,
- on operation and maintenance phase, and,
- sometimes, a retirement phase.

Note: These phases may overlap or be performed iteratively.

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- **activity** – any processing of artefacts, manually or automatic; solves tasks. Depends on **artefacts**, creates/modifies artefacts.

- **decision point** – special case of activity: a decision is made based on **artefacts** (in a certain state), creates a decision artefacts. Delimits phases, may correspond to milestone.
How Software $S$ May Have Been Created...

$S$ consists of modules $A$ and $B$.
Assume: specifications and test cases for $A$ and $B$ were available.
Person $\square$ coded $B$ (according to spec.), then person $\square$ tested $B$ (with test cases), no errors found.
Person $\square$ coded $A$, with the help of person $\square$. Then person $\square$ tested $A$, some errors found.
Person $\square$ fixed $A$, person $\square$ tested again, no errors found.
$A$ and $B$ ready caused a positive decision, then person $\square$ integrated $A$ and $B$ and obtained $S$.

How the Plan for Creating $S$ May’ve Looked Like...

$S$ consists of modules $A$ and $B$; specifications and test cases for $A$ and $B$ are available.
Some $\text{prg}$ codes $B$ (according to spec.), then some $\text{tst}$ tests $B$ (with test cases), and creates test report.
Some $\text{prg}$ codes $A$, with the help of some $\text{prg}$. Then some $\text{tst}$ tests $A$, and creates test report.
If errors in $A$ found, some single $\text{prg}$ fixes $A$, some $\text{tst}$ tests again, and creates test report.
If $A$ and $B$ ready causes a positive decision, then some $\text{int}$ integrates $A$ and $B$ and obtains $S$. 
A software module $M$ has a responsible $\text{prg}$. Any number of $\text{prg}$ may help with work on $M$.

A software module $M$ is created/modified by activity coding.

Activity coding depends on a specification of $M$, and may consider a positive test report for $M$.

The responsible $\text{prg}$ (and the helper $\text{prg}$’s) participate in activity coding.

Activity coding is done, if $M$ exists and there is a negative test report for $M$ (all tests passed).

A test report for a module $M$ has a responsible $\text{tst}$.

A test report is created/modified by activity testing.

Activity testing depends on software module $M$ and tests (in state “finished”) for $M$.

The responsible $\text{tst}$ participates in activity testing.

Activity testing is done, if $M$ exists and there is a negative test report for $M$ (all tests passed).

A ready decision for modules $M_1, \ldots, M_n$ has a responsible $\text{mgr}$.

A ready decision is created/modified by decision point $\text{ready?}$.

Decision point $\text{ready?}$ depends on negative test reports for $M_1, \ldots, M_n$.

The responsible $\text{mgr}$ participates in decision point $\text{ready?}$.

Decision point $\text{ready?}$ is done, if a positive decision exists.

A software $S$ has a responsible $\text{int}$.

It is created by integrating modules $M_1, \ldots, M_n$.

A software is created/modified by activity integration.

Activity integration depends on software modules $M_1, \ldots, M_n$ in state “finished”.

The responsible $\text{int}$ participates in activity integrate.

Activity integration is done, if $S$ exists.
**Building Blocks Can Be Arbitrarily Complicated**

- **Example:** Distinguish coding and fixing software.

- If there is a negative test result for $M$,
  - a **lead programmer** is responsible for fixing $M$,
  - the **programmer** who was responsible for the initial version assists;
  - fixing depends on the **test cases**, in addition to the specification of $M$;
  - a **report** is created (analysis of the error, documentation of the fix).

- By using such **building blocks**, the project manager
  - can prescribe particular procedures,
  - analyse, which **roles** need to be filled in a project,
  - avoid to “forget” things.
By the Way: Process Model of Tutorials
Process vs. Procedure Models
**Process Description and Reference Model**

**process description** – documented expression of a set of activities performed to achieve a given purpose.

NOTE: A process description provides an operational definition of the major components of a process.

The description specifies, in a complete, precise, and verifiable manner, the requirements, design, behavior, or other characteristics of a process. It also may include procedures for determining whether these provisions have been satisfied.

Process descriptions can be found at the activity, project, or organizational level.

IEEE 24765 (2010)

**process reference model** – a model comprising definitions of processes in a life cycle described in terms of process purpose and outcomes, together with an architecture describing the relationships between the processes.

IEEE 24765 (2010)

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**Process vs. Procedure Model**

(Ludewig and Lichter, 2013) propose to distinguish: process model and procedure model.

- A **Process model** (’Prozessmodell’) comprises
  - (i) **Procedure model** (’Vorgehensmodell’)
    - e.g., “waterfall model” (70s/80s).
  - (ii) **Organisational structure** – comprising requirements on
    - project management and responsibilities,
    - quality assurance,
    - documentation, document structure,
    - revision control.

    e.g., V-Modell, RUP, XP (90s/O0s).

- In the literature, process model and procedure model are often used as synonyms; there is not universally agreed distinction.
Anticipated Benefits of Process Models

- **“economy of thought”**
  - don’t re-invent principles.

- **quantification, reproducibility**
  - one can **assess the quality** of how products are created (→ CMMI).
  - Identify weaknesses, learn from (bad) experience, improve the process.

- **fewer errors**
  - e.g., testing a module cannot be forgotten because the ‘ready’ decision point depends on module with “test passed” flagged.

- **clear responsibilities**
  - fewer “I thought you’d fix the module!”

- **Process modelling** is easily **overdone** – the best process model is worthless if your software people don’t “live” it.

- Before introducing a process model
  - understand what you have, understand what you need.
  - process-model as much as needed, not more (→ tailoring).
  - assess whether the new/changed process model makes matters better or worse (→ metrics)

- **Note:** customer may require a certain process model.

Content

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    - phase, milestone, deadline
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- **Development Process Modelling**
  - process vs. process model

- **Procedure and Process Models**
  - “Code and Fix”
  - The (infamous) Waterfall Model
• Project: has (among others)
  • project owner, project leader
  • goals (Excursion: Risk)
  • process – each project has one

• processes can be modelled
  • descriptive ("we did it like that"), or
  • prescriptive ("please do it like that")

• A process model relates
  • roles, artifacts, activities, decision points
  • relations: responsibility, dependency, creation/modification.

• A process model can allow us to (→ exercises)
  • devise a schedule (who does what when)
  • estimate and control phases and deadlines.

• Distinguish procedure model and process model.

• Example: The Waterfall procedure model.

References
References


